The Analysis of Chlorinated Phenols Pollutants Using Diamond Microelectrodes

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Abstract

A boron-doped diamond microelectrode was employed for the amperometric detection of chlorinated phenols in capillary electrophoresis (CE-EC). Detection was made in both the direct and indirect modes. The microelectrode was prepared by (i) coating a thin film of boron-doped polycrystalline diamond on a sharpened platinum wire (76-μm diameter) and (ii) sealing the coated wires in a polypropylene pipette tip. The diamond microelectrode, in the end-column format, exhibited a low and stable background current with low peak-to-peak noise. The electrode performance was evaluated in terms of the linear dynamic range, sensitivity, limit of quantitation, and response precision for the detection of several important chlorinated phenols (2-chlorophenol, 3-chlorophenol, 4-chlorophenol, 2,4-dichlorophenol, 2,4,6-trichlorophenol, and pentachlorophenol). The diamond microelectrode exhibited outstanding detection figures of merit for these contaminants in the direct amperometry. For example, the mass limit of detection for 2-chlorophenol in the direct amperometric mode was 14 fg (12 ppb S/N = 4) and the relative standard deviation of the peak height for 9 injections was 4.7 % (1.1 nL inj.). The separation efficiency was greater than 100,000 plates/m for all seven analytes. Water from a local river was spiked with chlorinated phenols and analysed. The first step in the analysis was extraction of the phenols by solid phase extraction prior to analysis. The preconcentrated phenol solution was then analyzed using CE-EC. The preconcentration by solid phase extraction lowered the limit of quantitation to low ppb to high ppt level.
A diamond microelectrode was also employed for the indirect amperometric detection detection of these pollutants in CE. In this approach, ferrocene carboxylic acid was added to the run buffer as the electrophore. Good reproducibility was observed for the separation and detection of 2-chlorophenol, 3-chlorophenol, and 2,4-dichlorophenol. The mass limit of detection for these analytes was in the pg (low ppm) range. Data for both direct and indirect amperometry will be presented.